Searching & Hash Tables

CS1812/13: Object Oriented Programming II
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(based on slides by Dr Johannes Kinder)

Searching

- Many data structures are good at adding and removing data
- How to *search* for a particular value?
  - Decide whether an element is contained in a data structure

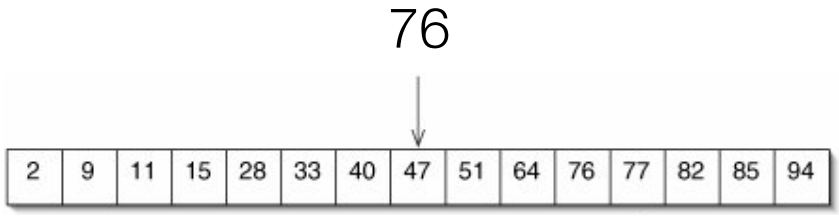
Linear Search

- Compare against each element
- If array has *n* elements, the algorithm needs on the order of *n* steps: the algorithm is in ***O(n)***, it is ***linear***

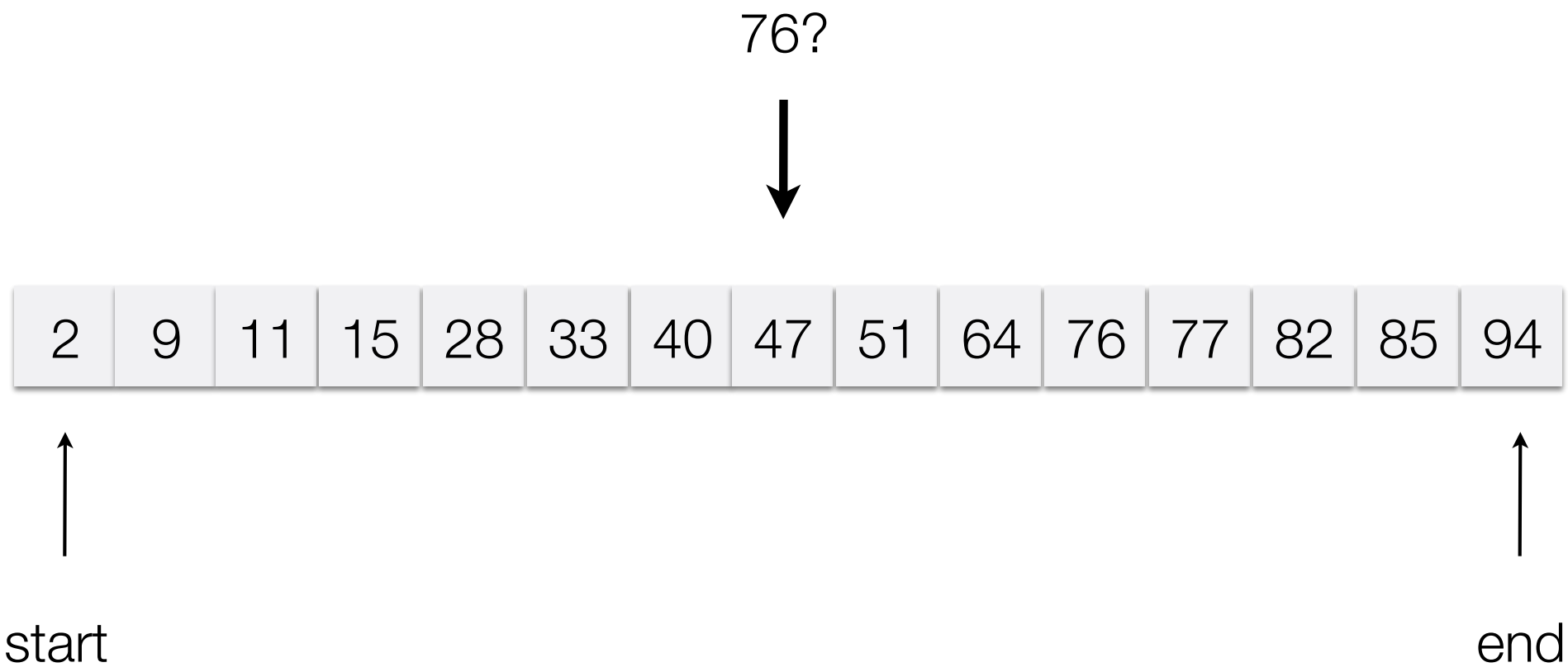
```
static boolean linearSearch(int[] arr, int val) {
  for (int x : arr) {
    if (x == val) {
      return true;
    }
  }
  return false;
}
```

Binary Search

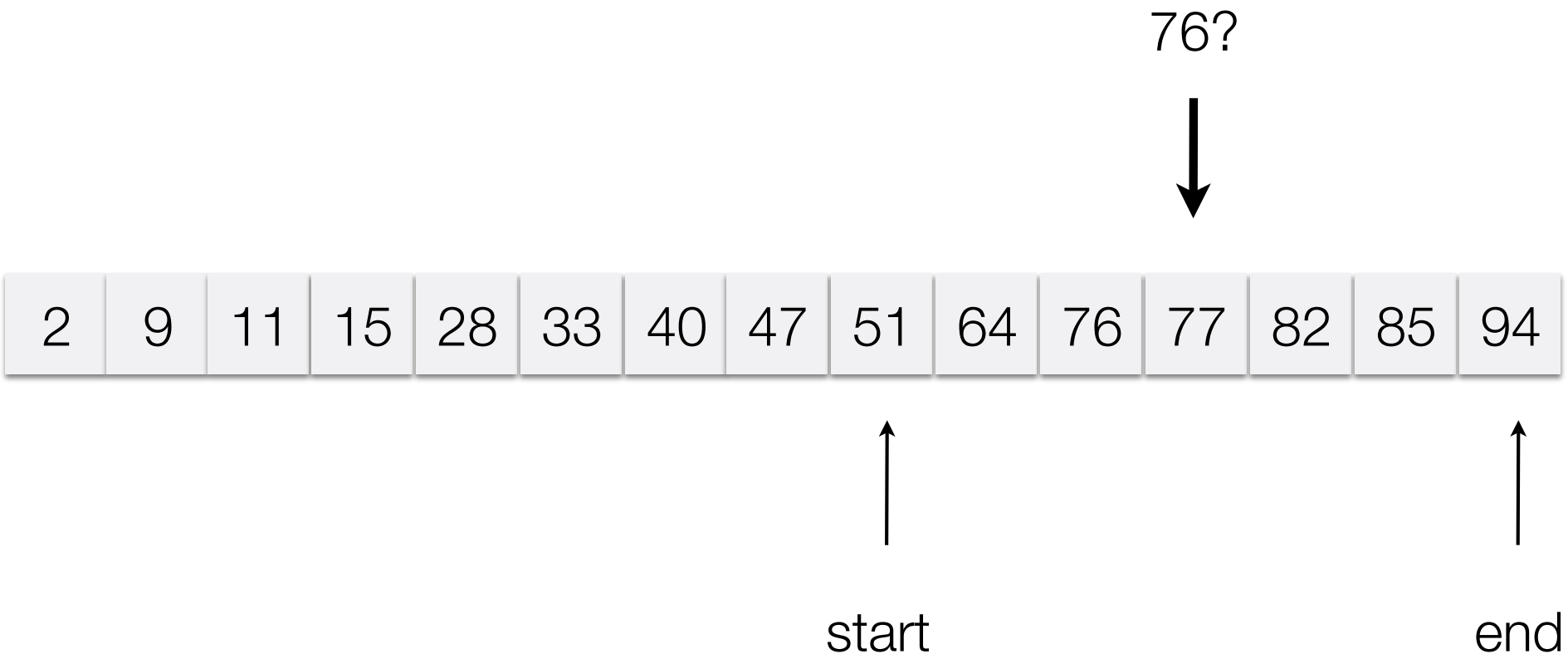
- What if the array is sorted?
- Idea
  - Compare against middle element → value has to be left or right
  - Recursively search in left or right half of the array



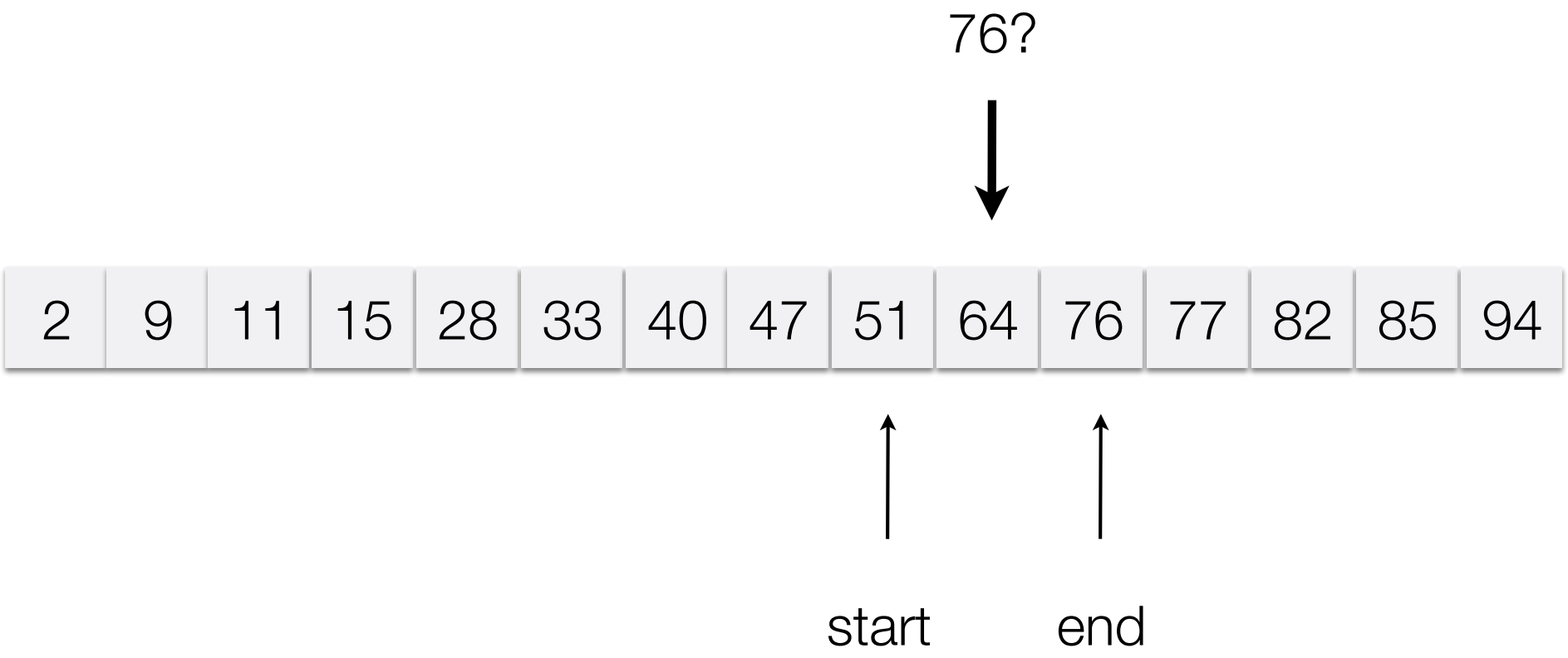
Binary Search



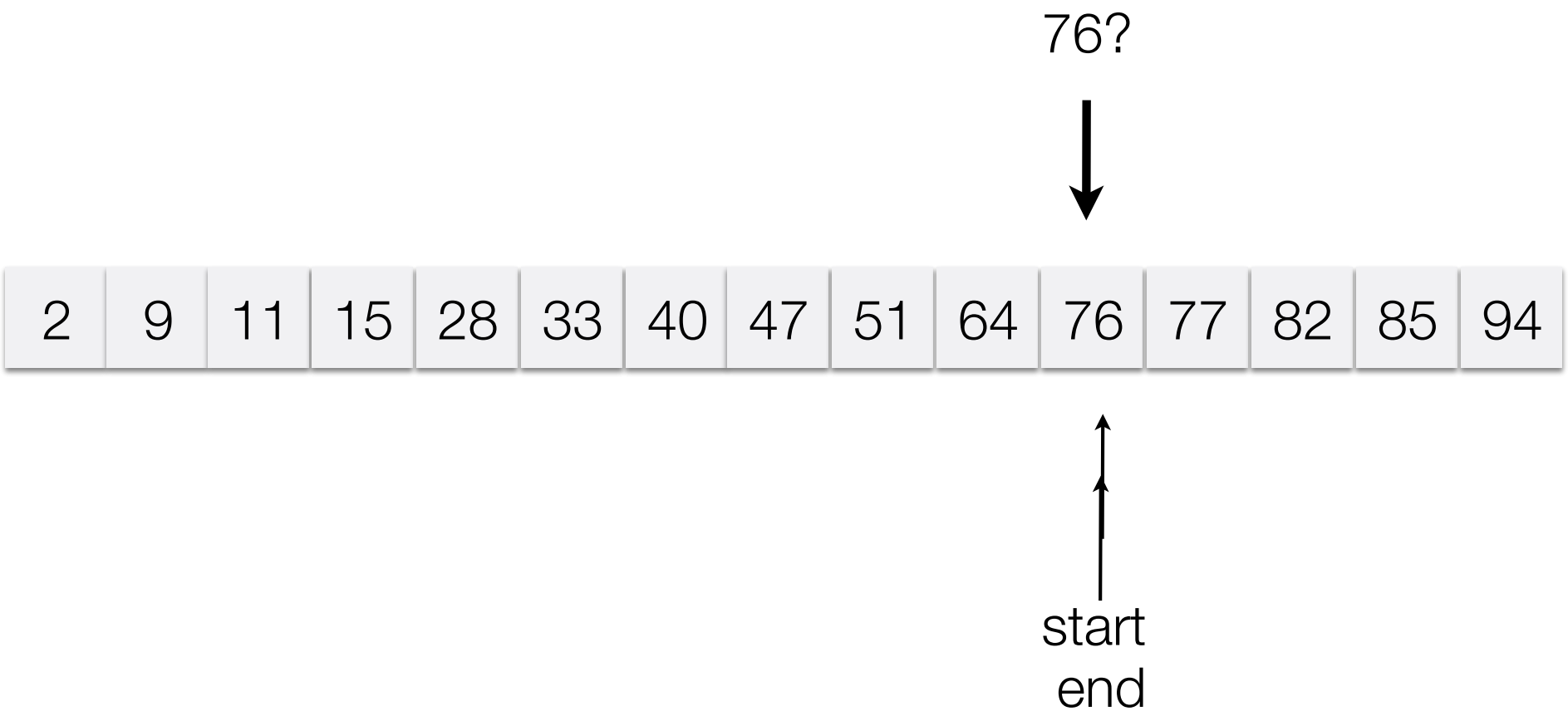
Binary Search



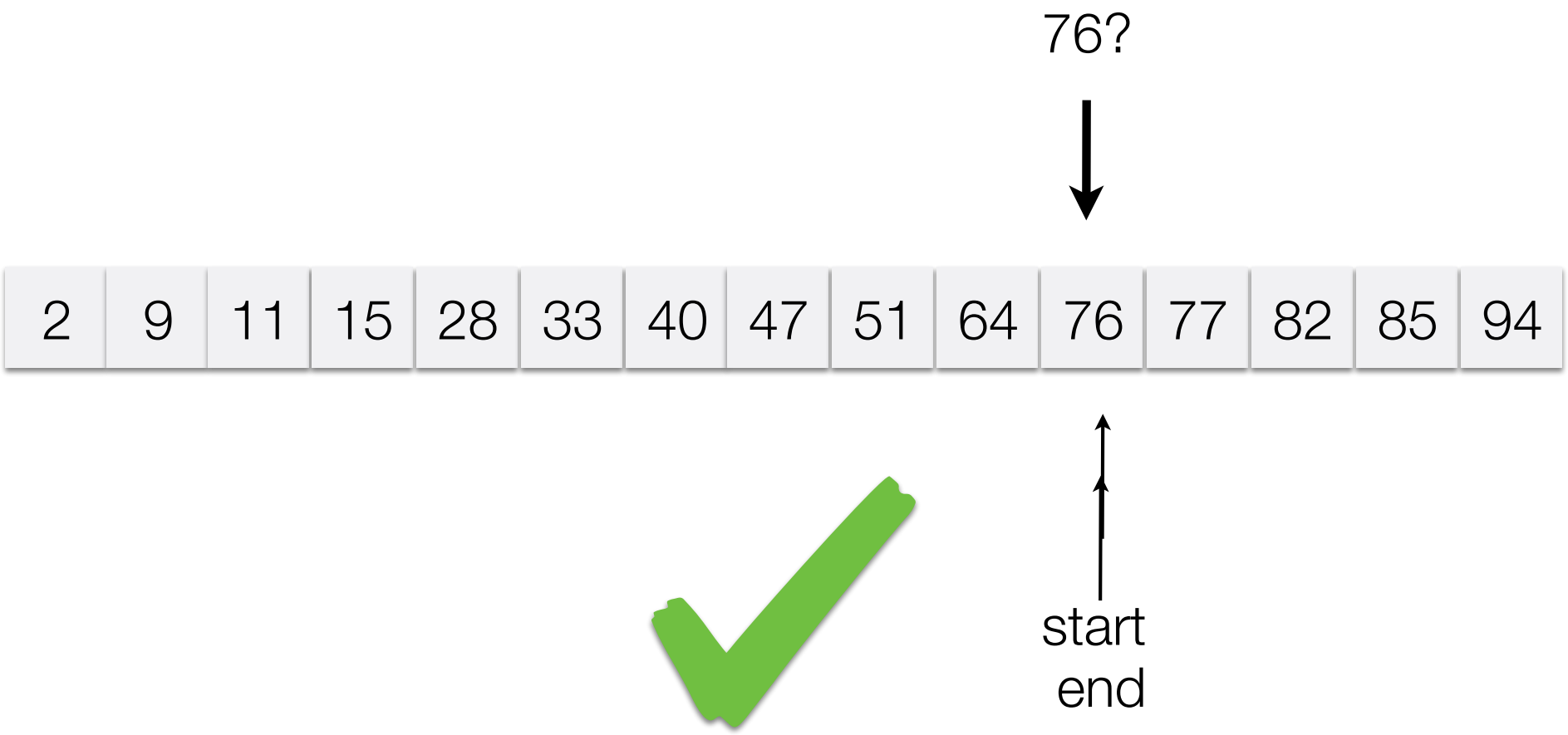
Binary Search



Binary Search



Binary Search



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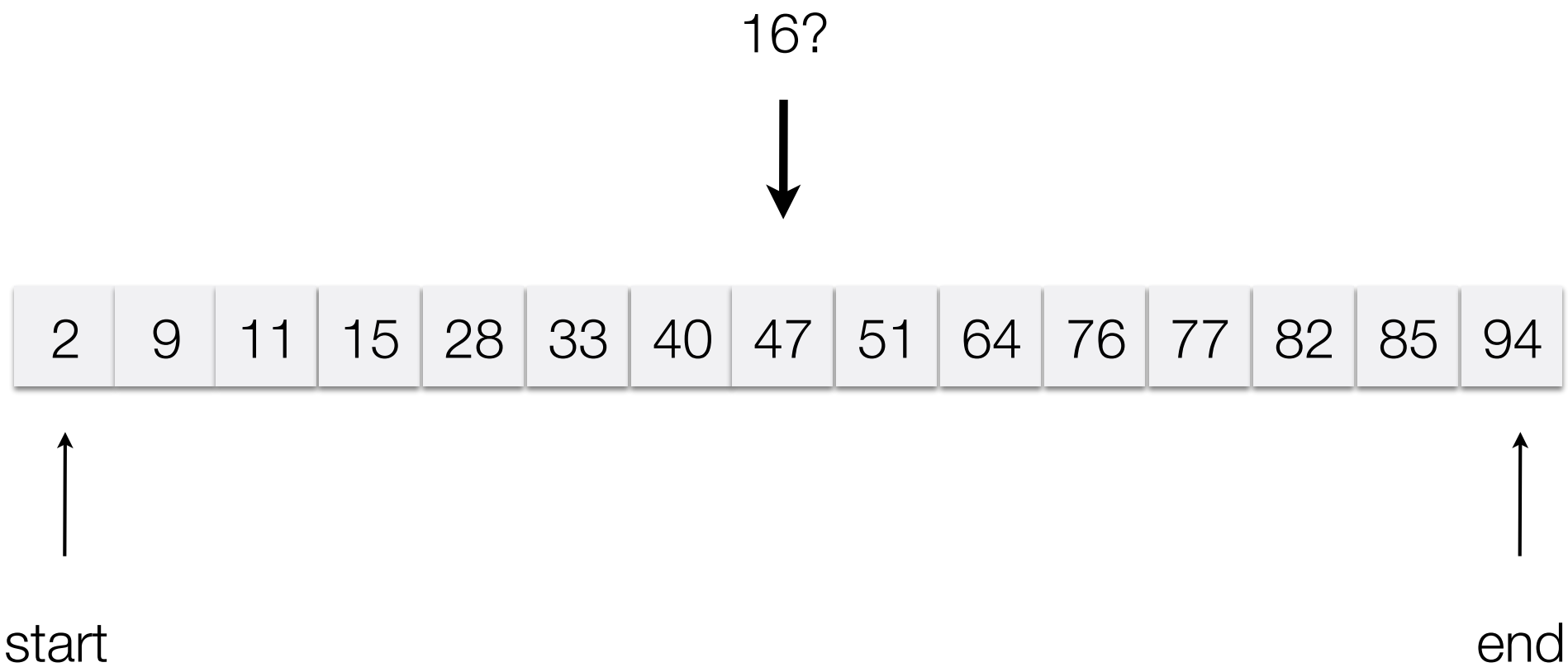

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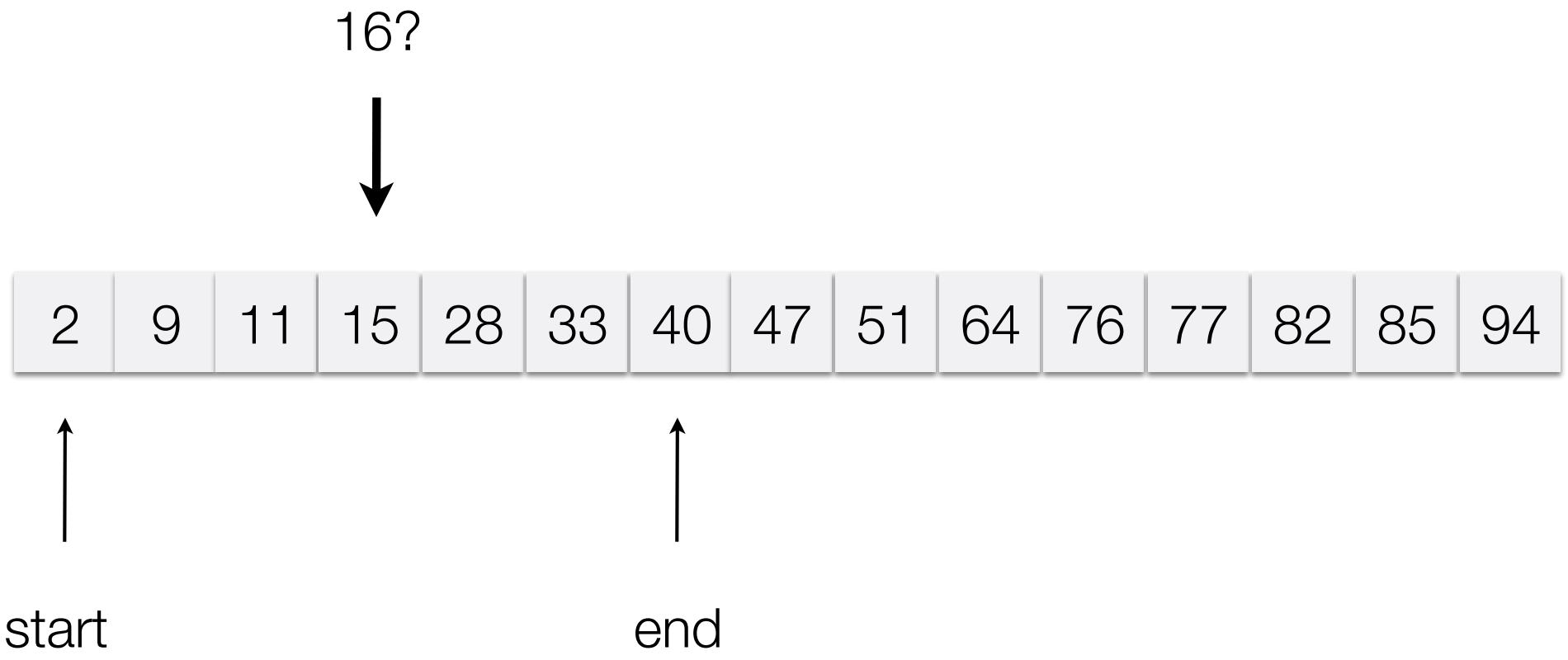

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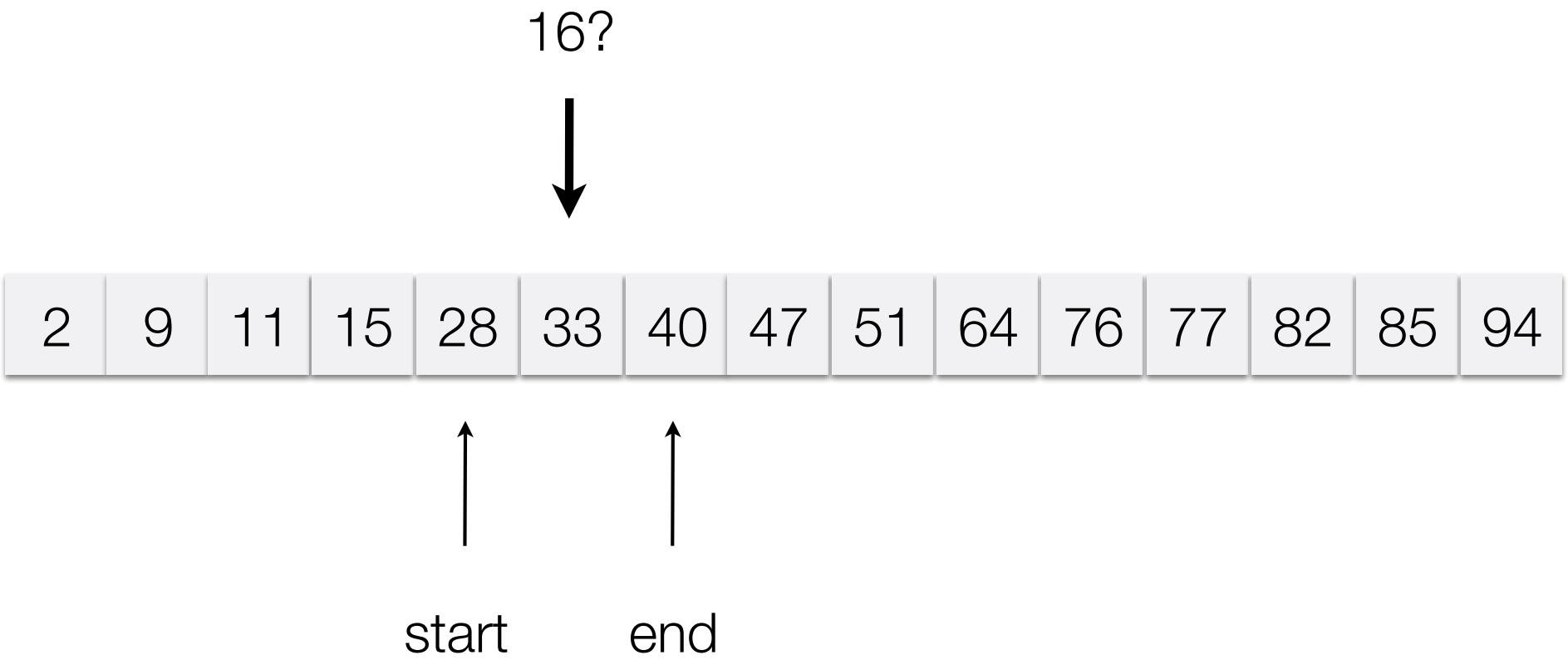

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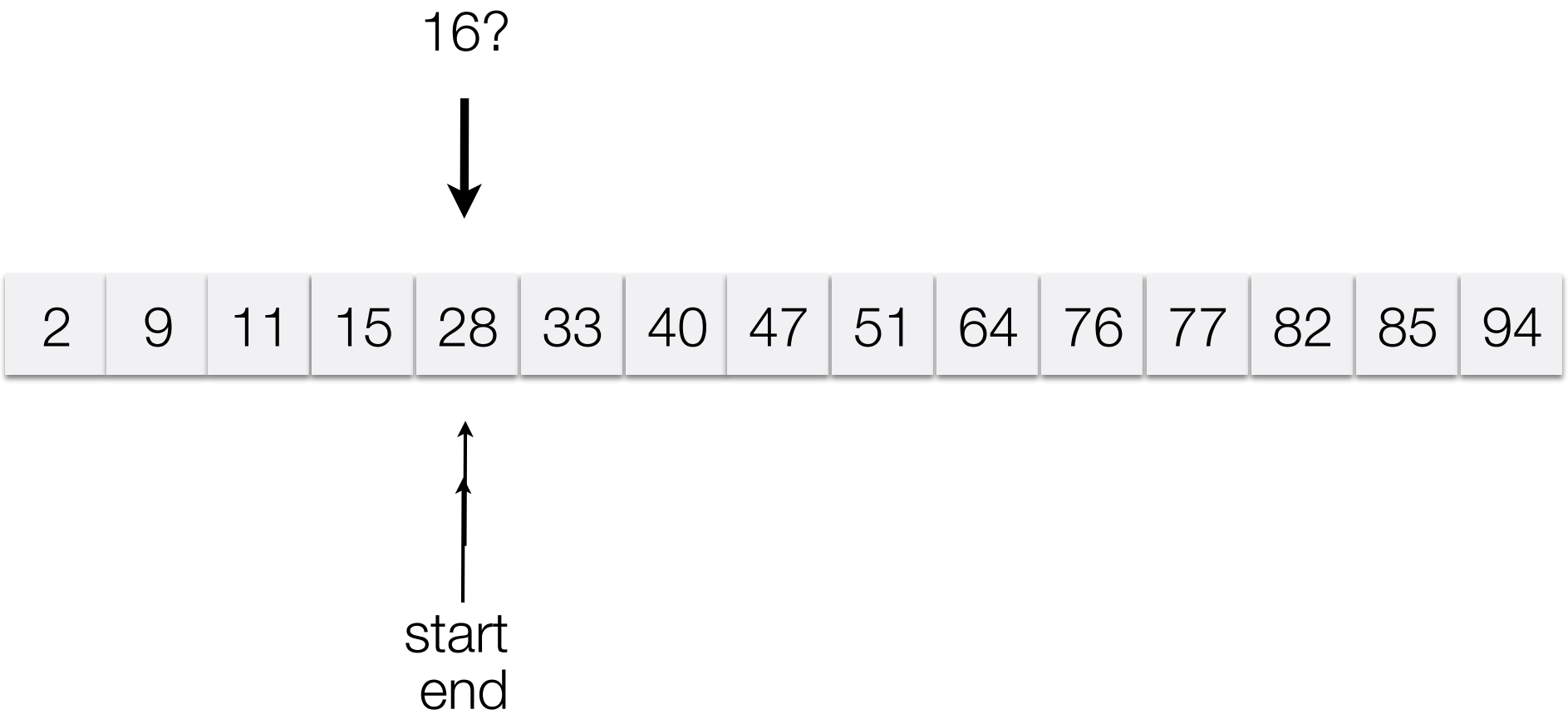

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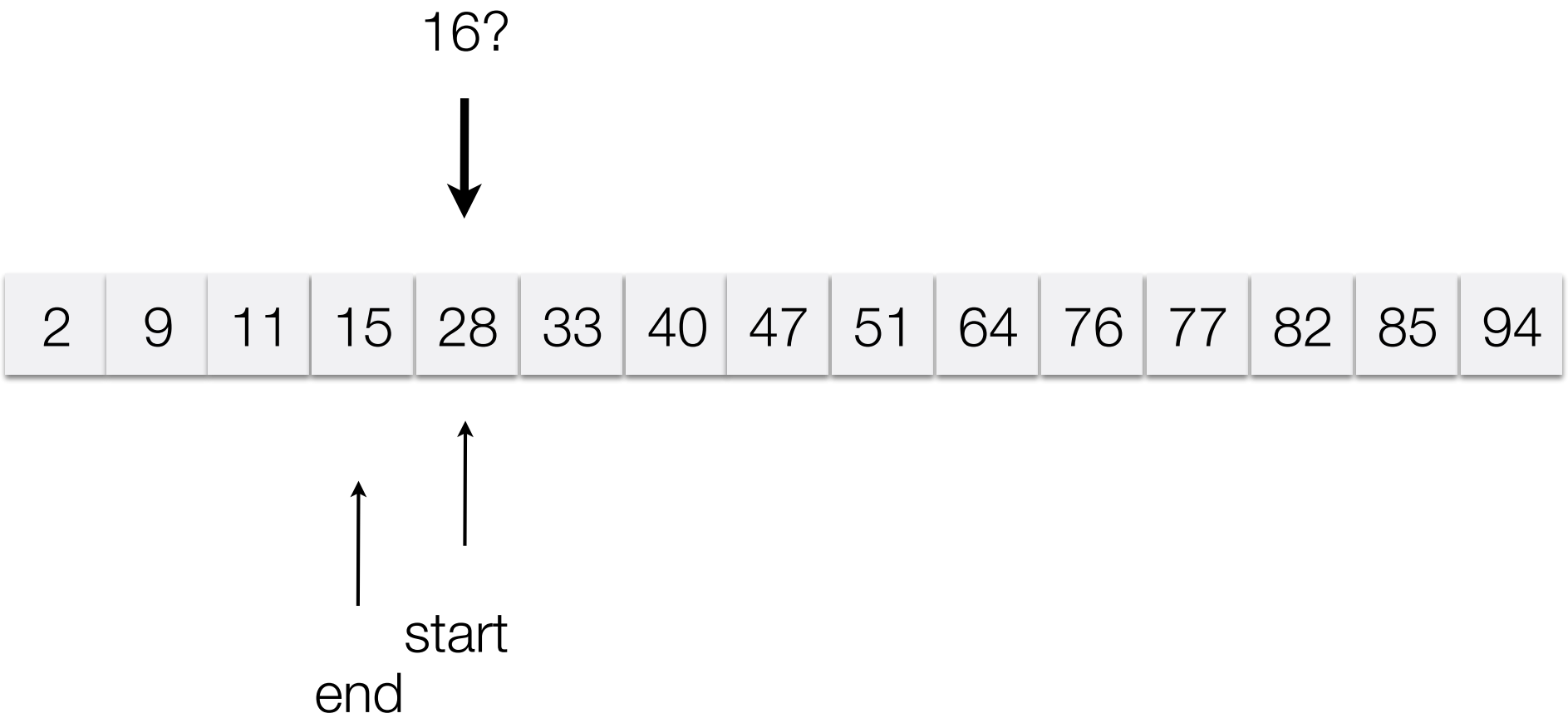

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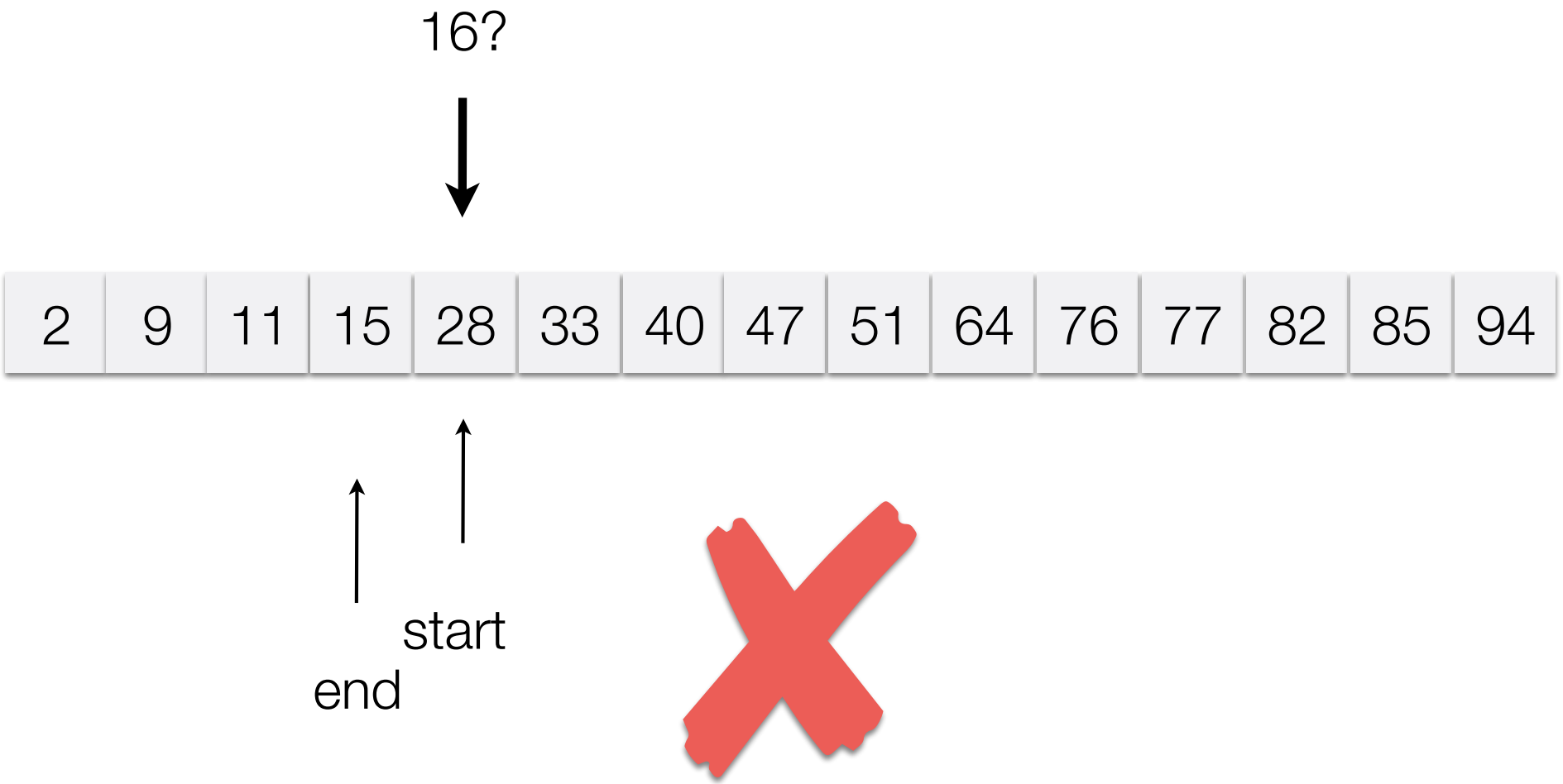

Binary Search

- If array has *n* elements, algorithm needs $\log_2(n)$ steps
- The algorithm is in $\boldsymbol{O(\log_2(n))}$, it is ***logarithmic***

```
static boolean binarySearch(int[] arr, int val, int start, int end) {
  if(start > end) return false;
  int middle = (start + end) / 2;
  if(arr[middle] == val) {
    return true;
  } else if (val < arr[middle]) {
    return binarySearch(arr, val, start, middle - 1);
  } else {
    return binarySearch(arr, val, middle + 1, end);
  }
}
```